

Research article

Supporting success: teaching driving to learners with neurodevelopmental disorders

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Driving education can be challenging for individuals with neurodevelopmental disorders (NDDs) due to the various symptoms which accompanies the disorders. However, previous research on NDDs and driving has prioritized cognitive deficits over specific mitigation strategies for driver training. This study aims to explore driving instructors' experiences of teaching individuals with NDDs with the research questions: (i) what challenges do driving instructors experience when working with individuals with NDDs during the process of teaching and learning to drive? and (ii) how do driving instructors address these challenges in terms of teaching methods and strategies? Thirteen certified Swedish driving instructors with experience teaching students with NDDs participated in semi-structured interviews which were analyzed using qualitative content analysis. The findings reveal both cognitive and structural challenges, for example difficulties processing information in various traffic situations and the need for additional resources. The driving instructors emphasized the importance of clear communication and creating a structured and supportive environment. To meet the needs of learners with NDDs, they described using a range of adaptive strategies. These include breaking down tasks into smaller steps, using repetition, giving clear and concrete instructions, and incorporating illustrations and demonstrations to enhance understanding. The results highlight the importance of targeted, individualized support within driver education for learners with NDDs. They also provide practical insights into current teaching approaches and highlight areas for recommended focus. By shedding light on instructional strategies, this study informs both practice and policy, contributing to a more inclusive, effective and accessible driver education system for individuals with NDDs.

1. Introduction

Obtaining a driver's license enhances mobility and unlocks several opportunities. For many adolescents it marks a step toward independence, enabling work and social engagement (McDonald & Mirman, 2022; Kenyon et al., 2002). While a driving license improves quality of life, it also comes with risks. Adolescents are overrepresented in traffic crashes due to factors like inexperience

and developmental immaturity, which weakens cognitive abilities critical for safe driving, such as risk assessment and hazard response (Banz et al., 2019; Walshe et al., 2017). Furthermore, the cognitive requirements for safe driving may present additional challenges for adolescents with neurodevelopmental disorders (NDDs) (Bednarz et al., 2021; Ross et al., 2018; Vaa, 2014). The term NDD includes various diagnoses, such as

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Attention Deficit Hyperactivity Disorder (ADHD), Developmental coordination disorder (DCD) as well as Autism Spectrum Disorder (ASD) (American Psychiatric Association, 2013). Moreover, comorbidity is common, for instance, ADHD and DCD have an estimated co-occurrence rate of approximately 50%, which is seldom mentioned in previous literature on driving ability (APA, 2013; Bonti et al., 2024). In Sweden, approximately 10 percent of young people have been diagnosed with an NDD (The Swedish Brain Foundation, 2017; The National Agency for Special Needs Education and Schools, 2024) and certain characteristics of various NDDs may affect an individual's ability to drive and to learn how to drive (Bednarz et al., 2021; Ross et al., 2018; Vaa, 2014).

In Sweden, individuals may begin supervised driving practice at age 16, either privately or at a driving school, although the driving test cannot be taken until age 18 and a valid learner's permit is required (The Swedish Transport Agency, 2024). When applying for this permit, applicants must currently submit a health declaration, and those reporting NDDs, such as ADHD or ASD, must provide a physician's medical certificate confirming fitness to drive (The Swedish Transport Agency, 2010). These regulations are now under revision, and in 2026 the medical certificate requirement will be removed due to insufficient evidence supporting its necessity.

There is a considerable amount of research on two of the most common NDDs, ADHD and ASD. For drivers with ADHD, the core symptoms of inattention, impulsivity and hyperactivity have been associated with behaviors linked to an increased risk of accidents, such as being prone to distractions, impulsive decisions, and unsafe behaviors like speeding or unsafe lane changes (Groom et al., 2015; Vaa, 2014). Moreover, for drivers with ASD, deficits in executive functioning, such as attention, multitasking, and cognitive flexibility have been associated with difficulties when driving (Ross et al., 2018; Myers et al., 2021; Classen et al., 2013).

There is less research on other NDDs and driving, although certain characteristics associated with these disorders may also influence driving ability. For example, learning to drive is often more challenging for individuals with intellectual developmental disorder (IDD) due to deficits in intellectual and adaptive functioning (APA, 2013; Brooks et al., 2014). These deficits affect functions essential when learning to drive, such as reasoning, planning, academic learning, and learning from experience (APA, 2013; Brooks et al., 2014).

Moreover, research suggests that Developmental Coordination Disorder (DCD) complicates driving, primarily due to challenges in automating complex motor skills (APA, 2013; de Oliveira & Wann, 2011; Shipley et al., 2024). Compared to controls, individuals with DCD exhibit difficulties with steering through bends, parking, distance estimation, and consistently checking mirrors (de Oliveira & Wann, 2011; Gentle et al., 2021; Kirby et al., 2011; Shipley et al., 2024). Another under-researched NDD in this context is Language Disorder. A longitudinal study found that by age 24, individuals with language impairment were significantly less likely to hold a driver's license, with the theoretical examination posing a particular challenge (Durkin et al., 2016).

Research on mitigating driving difficulties focuses primarily on ASD, emphasizing the need for structure and clarity in training (Ross et al., 2018; Patrick et al., 2018; Vindin et al., 2021). For these individuals, tailored instruction featuring shorter, more frequent lessons and repetitive practice of cognitively demanding tasks like multitasking is recommended (Cox et al., 2016). Regarding ADHD and ASD, effective communication is considered essential to address specific learner needs (Thorslund & Lidestam, 2025). Furthermore, simulator training has proven beneficial across various NDDs (Cox et al., 2017; Epstein et al., 2022; Randall et al., 2021).

To our knowledge, most NDD research focuses on driving challenges and capacities rather than mitigation strategies and when

addressed, the focus is predominantly on ASD. Only limited research examines teaching practices in driver education, with such practices often appearing as a minor component of ASD-focused studies (Vindin et al., 2021). Furthermore, while NDDs are highly heterogeneous and comorbidity is common (APA, 2013), most driving research targets single diagnoses and overlooks these aspects (e.g., Myers et al., 2021; Vindin et al., 2021; Chee et al., 2015). Notably, one of the few studies to investigate comorbidity suggests that individuals with combined diagnoses face significantly greater challenges than those with a single diagnosis (Thorslund & Lidestam, 2025).

Comorbidity and heterogeneity within NDDs complicate the development of tailored interventions (Cruz Puerto & Sandín Vázquez, 2024; Bonti et al., 2024). Addressing this requires a shift from diagnosis-specific approaches (e.g., ASD) toward a functional perspective focused on the capacities required for driving. Research should investigate how to facilitate these capacities and mitigate challenges throughout the learning process. Consequently, we use the term NDD to encompass both comorbidity and the inherent heterogeneity of these conditions, focusing on how to enhance capacity relative to potential challenges.

Research on driver education and NDDs has been performed in various countries, however the Swedish context remains under-researched. Only one major study has addressed this topic in the last decade (Almberg et al., 2015), focusing primarily on the learner's perspective. Since then, declining pass rates on driving exams further emphasize the need for updated findings (The Swedish Association of Driving Training Providers (STR), 2025). Notably, no Swedish study has focused specifically on driving instructors. As instructors play a pivotal role in tailoring education, their perspectives are essential for a functional driver training system, a need also highlighted in recent research (Thorslund & Lidestam, 2025). Additionally, although Almberg et al. interview driving instructors as well, they contrast learners with ADHD to

learners with ASD, missing the complexity of teaching learners with more than one NDD.

Most research to date has focused on cognitive challenges and fitness to drive rather than mitigation strategies during training. Given the significant obstacles faced by learners with NDDs, understanding how to better support their learning is crucial. Such insights are essential to ensure that future systemic improvements are inclusive and effective for all learners. Based on the above, the purpose of this study is to explore driving instructors' experiences of teaching individuals with NDDs. The following research questions have been formulated:

- What challenges do driving instructors experience when working with individuals with NDDs during the process of teaching and learning to drive?
- How do driving instructors address these challenges in terms of teaching methods and strategies?

2. Method

Due to the heterogeneity of NDDs as well as the prevalence of comorbidity, this study adopts a broad perspective rather than focusing on a single disorder. Instead, we explore the challenges as well as strategies and methods used in driver education for individuals with various NDDs. This approach acknowledges that driving instructors often operate without specific diagnostic information. Consequently, the emphasis lies on how instructors perceive and mitigate the functional challenges they observe in their students.

2.1 Participants

A total of 13 driving instructors (four women) participated in the study. The driving instructors were recruited by email, and the inclusion criterion was prior experience working with students with NDDs. In total, 22 driving schools were contacted by email, 19 schools were found through searching on Google and four driving schools

were previously known by the authors in a professional context to work with student drivers with NDDs. Out of the 22 schools contacted, 11 matched the inclusion criteria and nine were able to participate in the study. Furthermore, four of the 13 driving instructors who were interviewed were previously known by the authors, while the other nine driving instructors were identified through a Google search. The driving instructors who participated in the study worked at nine different driving schools in different parts of Sweden and had different amounts of working experience, in the range of 1.5 to 40 years.

One driving school was a vocational upper secondary school specializing in professional driver training, seven were standard driving schools, and one focused on students with special needs. The participants were informed about the purpose of the study, participated voluntarily, and provided their oral consent to participate.

2.2 Data collection procedure

To explore driving instructors' experiences, an inductive qualitative design with semi-structured interviews was used (Taylor et al., 2015). This method allows researchers to follow up on significant statements and adapt to participants' unique experiences while maintaining a clear structure through a predetermined interview guide (Merriam & Tisdell, 2015; Adeoye-Olatunde & Olenik, 2021).

The interviews were conducted by the first author through Microsoft Teams in October and November 2024 and lasted between 45 and 60 minutes. With the participants' consent, the interviews were recorded and transcribed verbatim using the Microsoft Teams transcription feature; all transcripts were subsequently verified and corrected for accuracy. The interview guide included several open-ended questions where the participants could express their thoughts and experiences working with students with NDDs. Core topics included perceived challenges, interaction, and pedagogical tools. Examples of questions included; "What are

your experiences of teaching individuals with NDDs to drive" and "What do you consider the key to helping a person with NDDs successfully obtain a driver's license?". The participants' answers were then sometimes followed up with explorative questions and questions with a clarifying purpose from the interviewer. The study adheres to the COREQ criteria to ensure comprehensive reporting of the qualitative process (Tong et al., 2007).

2.3 Analyses

The data of the transcribed interviews were analyzed using content analysis procedures according to methodology described by Graneheim and Lundman (2003). Qualitative content analysis is commonly used in educational research and is well-suited for analyzing interview data, since it allows in-depth processing of the data and nuanced interpretation at multiple levels (Graneheim & Lundman, 2003). The analyses were done in collaboration between the first and the third author. The third author holds a PhD in Occupational Therapy, and has broad experience from rehabilitation research, the first author is a PhD candidate in cognitive science focused on driver education and NDDs, and the second author holds a PhD in disability research.

Initially, the transcribed interviews were read individually by the first and third author to obtain a general understanding of the data. After the initial read-through, units of meaning containing aspects related to the research questions were extracted from the transcripts. The units of meaning were condensed into shorter, more concise units, which were then analyzed by comparing their similarities and differences to create subcategories. The subcategories were later analyzed and organized into main categories. Examples of the coding process are provided in Table 1. During the analysis, the categories and subcategories were compared with the initial interview data. Throughout the process, the authors discussed and reflected on the findings together, deciding on appropriate categories and subcategories. Based on the

Table 1. Examples of the coding process

Meaning units	Condensed meaning units	Subcategory	Category
You need to watch your tongue, as most things can be interpreted so literally.	Watch your tongue, most things can be interpreted literally	Adapting communication	Creating facilitating learning conditions
It's tough because often repetition is what eventually leads to results.	Repetition is what leads to results	Repetition	Teaching methods and strategies for learning

interviews, the categories and subcategories, and the author's understanding of the underlying meanings, an overarching theme was formulated.

To increase the credibility and trustworthiness of the data in this study, strategies presented by Granheim and Lundman (2003) were used. The qualitative study design made it possible to examine the research topic in depth and also allowed the participants to express their experiences. The categories and subcategories were compared with the data during and after the analysis to establish credibility (Granheim and Lundman, 2003).

3. Results

A main overarching theme emerged based on the driving instructors' experiences. The overarching theme, *Adapted and targeted support in a facilitating learning environment*, summarizes and depicts what needs to be taken into consideration to enable successful driver's license acquisition for student drivers with NDDs. According to the driving instructors obtaining a driver's license can be challenging for both the students and the driving instructors due to the intrinsic nature of NDDs combined with the complexities of driving. However, with the driving instructors' knowledge and expertise concerning appropriate and strategic teaching methods as well as resources, obtaining a driving license is possible. As one driving instructor said: *"It's not difficult if you do it the right way."*

The main theme contained three categories: 1) *Challenges during driver education*, 2) *Creating facilitating learning conditions*, 3) *Teaching methods and strategies* (see Table 2 for an overview). The categories and

subcategories are illustrated with quotes from the participants.

3.1 Challenges during driver education

Obtaining a driver's license is, according to the driving instructors, often more demanding for students with NDDs compared to neurotypical students, as they face more challenges and require more time to learn.

3.1.1 Cognitive processing and managing information in traffic situations

A common challenge for students with NDDs, according to half of the driving instructors, was handling situations with a lot of stimuli and information. The students were often described as becoming more stressed and struggling to stay focused. This was described as problematic since traffic situations and driving involve managing a traffic environment which requires processing of multiple sources of information simultaneously. As one driving instructor described it:

"When there are a lot of impressions at the same time, it's difficult to filter, hard to know where they should place their vehicle, what their primary focus should be."
(Participant no 5)

The struggle to handle situations with a lot of stimuli was also described as affecting the student's ability to make quick and safe decisions. Moreover, one driving instructor stated that it is not uncommon for students with ADHD to make risky decisions. She said that some students with ADHD tend to act risky in certain traffic situations, such as driving into a traffic circle without waiting for a safe opportunity to enter. The driving

Table 2. An overview of the overarching theme, categories and subcategories

Categories	The main theme		
	Adapted and target support in a facilitating learning environment		
	Challenges during driver education	Creating facilitating learning conditions	Teaching methods and strategies
Subcategories for each category	Cognitive processing and managing information in traffic situations	Communication as a tool	Adaptations based on individual needs and prerequisites
	Reasoning required for driving	Information as a resource	Enhancing understanding
	Theoretical aspects	Establishing trust and rapport	Stepwise learning and Repetition
	Requiring extra resources	Structure and clarity	

instructor also described how some students with ADHD had difficulty understanding the consequences of their actions, as well as showing impulsiveness and a tendency to become angry with other road users. In some cases, this could result in difficulties when interacting with other drivers.

3.1.2 Reasoning required for driving

A third of the participants described the challenges that students with an ASD diagnosis had with flexibility in their reasoning, for example when applying traffic rules, regarding other people’s behavior and in unexpected situations. The driving instructors referred to the challenge as “seeing everything as black and white”. One driving instructor described how many students seek a step-by-step guide for all kinds of traffic situations.

“If you’ve been driving too fast on a street in a situation where there are no parked cars or people out, it might be okay, but another time it might not be - they would prefer to have a template to do things the same way. This can be difficult for this group.” (Participant no 2)

A couple of driving instructors have had the experience that students with ASD are often skilled at following traffic rules but have difficulty being flexible, reading between the lines, and not following rules when necessary, e.g., to avoid risky situations. Another challenge was difficulties understanding abstract concepts, such as the possibility of something happening even if it had not

happened the last time they, for example, drove past a specific place.

“It is very difficult, it becomes too abstract for the student to understand that something can happen or something can come out when it didn’t before.” (Participant no 2)

Furthermore, social understanding and reasoning was also something that was described as a challenge for students with an ASD diagnosis. More than a third of the driving instructors highlighted different challenges connected to social cognition, such as communication with the instructors and social interactions in traffic situations.

3.1.3 Theoretical aspects

More than two thirds of the participants described that one challenge when obtaining a driver’s license for students with NDDs is the theoretical part and that they often need more support with this. The driving instructors describe difficulties in understanding words and needing words to be explained. They also describe struggles with concentration, sitting down and studying for a long time, and difficulties having the discipline to sit down and study if the students are alone. A couple driving instructors stated that students with ADHD or with ADHD and another diagnosis often struggle with the theoretical part of driver education.

3.1.4 Requiring extra resources

Due to the challenges that students with NDDs face and the need for adaptations in teaching methods, the participants said that students with NDDs often require more lessons. This leads to higher costs, which can be a concern if they exceed the student's budget. One instructor noted that financial limitations may impact whether students continue with their driver education at the driving school. Another participant mentioned that additional driving lessons might lead some parents to take on the task themselves, either because they cannot afford the lessons or because they consider them to be too expensive, which can result in the student not receiving the support they need. One driving instructor explained:

"It is significantly more time consuming than driving with someone who doesn't have it, and that means the driver's license becomes much more expensive, and parents may not have the money to spend. So, they try to do it themselves." (Participant no 4)

The driving instructors also stated that the driver's license process is usually more demanding for both the driving instructor and the student when the student has an NDD. The driving instructor needs to put more effort into the interaction, planning the driving lessons, as well as the educational methods, and the student must put in more work, which is described as one of the main challenges:

"Yes, I mean, that in itself is the challenge, I would say. It requires more from them, and it requires more from us" (Participant 1)

To summarize, the driving instructors noted that individuals with NDDs often struggle with the cognitive demands of driving. They also described that students with NDD diagnoses often require additional resources from both the driving school in the form of time and specialized knowledge, and from the student,

including greater investments of time, money, motivation, and energy.

3.2 Creating facilitating learning conditions

For students with NDDs to overcome their challenges during driver education, it is important to create learning conditions that support and facilitate their learning process.

3.2.1 Communication as a tool

The importance of communication was often described as a key factor for reaching the student as well as creating optimal learning conditions. The driving instructors highlighted the importance of different aspects of communication to facilitate learning. They emphasized the importance of actively listening to what the students say and asking questions to encourage the students to provide more information, for example, about themselves and what they need. One driving instructor provided examples of questions they ask:

"How do you usually learn best? Is there something specific you'd like me to know about you so I can teach you in the best way, and maybe use the example: How have you learned best when you were in school, for instance?" (Participant no 3)

When talking with the students the driving instructors highlighted the importance of not using too many words and carefully choosing the words they use, since it might become overwhelming or get misinterpreted. Around three fourths of the driving instructors also talked about the importance of being attentive, not only listening to verbal cues but also observing non-verbal cues and reading between the lines. More than one third of the driving instructors commented that some students sometimes have struggles communicating, requiring instructors to "guide" them by asking questions to elicit information. One instructor also shared the experience of students not giving sufficiently informative answers to questions, and the

instructor managed this by observing the student's behavior in a certain situation to determine if they had actually understood:

“Instead of asking the question, because you don't really know if you'll get an answer, you might get a 'yes' when you could just as easily get a silent response. Here, I might need to get the student to perform this action to get a confirmation and see that it has really stuck.” (Participant no 5)

A few driving instructors explained that, based on the student's verbal or non-verbal communication, they adopt an investigative approach to gather additional information, often using questions. The driving instructors described guiding the student with questions to gain the information required to tailor the educational process to the student's needs. The driving instructors clearly communicate to the students that they should express what they need and explain to the students why it is important. One instructor mentioned the importance of “two-way” communication and the need to sometimes help the student participate in this, especially since many students have difficulties with social communication. The driving instructors also emphasized the importance of clearly communicating their own role, the student's role, and how these roles interact, ensuring that the driving instructor is there to support the student's learning and that the process is a collaborative effort between the two.

3.2.2 Information as a resource

More than two thirds of the driving instructors reported that having information about the student, such as how they best learn, their specific challenges, and the type of disorder they have is an important resource. One driving instructor said, *“The more information, the better.”* More than three-fourths of the driving instructors said that they use the information as a map to help adapt and shape the lessons to the student's advantage. Knowing more about the student was also

described as making it easier for the instructor to be flexible and adapt their communication style accordingly. Some driving instructors explained that if they know the student has difficulties communicating verbally, they apply strategies that accommodate this. Additionally, understanding the student's needs influences how the driving instructor decides to engage with them, which in turn impacts the student's learning process.

One third of the driving instructors mentioned the importance of the initial meeting with students, which sets the tone for future interactions, such as providing information about available support and assessing the students' needs. This session helps the instructors tailor their teaching to the student's learning preferences and specific needs. The driving instructors discussed how the structure of the educational process is adapted to meet the individual needs and preferences of students. They emphasized the importance of self-awareness in students, highlighting that understanding their own challenges and preferred learning methods is crucial for achieving success. This was viewed as a strength in some students with NDDs, it was described to aid the learning process. Additionally, they mentioned that parents often provide valuable insights concerning this.

“Be clear that it's important for them to ask and tell how they want it, because I am there for their sake, that's how it is.” (Participant no 5)

3.2.3 Establishing trust and rapport

The driving instructors described the importance of the first meeting for establishing trust and rapport. They explained that if the initial meeting does not proceed favorably, collaboration becomes challenging, since rapport and trust are crucial for the student to absorb information and share what's needed for creating an optimal learning environment. One driving instructor said:

*“If you don’t have that person’s trust, it doesn’t matter what you say.”
(Participant no 7)*

*book, remind, send SMS, and check, ‘Hello, are you awake?’ And then there are things they easily forget.”
(Participant no 6)*

To build rapport and trust, the driving instructors highlighted engagement strategies such as maintaining a calm, humble, and kind demeanor, while adapting communication to each student’s needs. They stressed the importance of focusing on the individual, ensuring they feel seen and supported. Building the student’s confidence by acknowledging their successes boosts motivation and makes learning enjoyable. However, honesty about areas needing improvement is also crucial. More than a third of the participants also highlighted the importance of patience and understanding the challenges students might face:

“Understand that it’s not about unwillingness, but often about inability.” (Participant no 7)

3.2.4 Structure and clarity

The participants stressed that structuring the education process is especially important with this group, and that it often plays a central role in helping to plan and structure the educational process. For example, individuals with ASD are described as sometimes being active in creating structure. They are described as wanting predictability, i.e., to know what is going to happen, when, and how. They are also described as wanting a routine, for example, having the same time for lessons every week. Having structure, e.g., having the same time every week, is also described as beneficial for students with ADHD, though individuals with ADHD are also described as having difficulty maintaining structure. At one driving school, the driving instructors had a habit of reminding students by text messages, as they would otherwise forget their driving lessons:

“Many have a hard time getting things done; we almost have to act like a calendar for them. We have to

Some driving instructors described the need to support students in planning both their driving lessons and theoretical studies. Predictability was described as important for some students, and at times key to getting the students to practice theory. One instructor mentioned that having short recordings of the theoretical material was very helpful: students were described as finding comfort in knowing how long they had to concentrate on listening. To create structure, the driving instructors emphasized the importance of clear communication and preparing the student for the educational process. They discussed providing a clear picture of the end goal, outlining milestones, and explaining what obtaining a driver’s license would require.

In summary, the driving instructors believe creating a supportive learning environment is crucial for individuals with NDDs to obtain a driver’s license. They achieve this by focusing on effective communication, building rapport and trust, and assisting with structure and planning. Together, communication, understanding the student, and earning their trust form the foundation for optimal learning conditions.

3.3 Teaching methods and strategies for learning

For students with NDDs to successfully learn to drive despite challenges, the use of effective teaching methods and strategies is essential.

3.3.1 Adaptations based on individual needs and prerequisites

All participants described how they adapt their teaching to meet each student’s individual needs. They discussed the importance of recognizing what each individual student requires to learn, noting that all students are different. One instructor says:

“It’s about meeting the unique individual in their unique problems, no matter what the diagnosis is called.” (Participant no 8)

They emphasized that since a diagnosis does not mean all students require the same adaptations, focus should be on addressing individual challenges and finding tailored strategies. The driving instructors expressed that there is no universal pedagogical solution for all students with one specific disorder, and one instructor stressed the importance of flexibility in adapting to each student’s needs:

“You have to be a bit of a chameleon as a teacher, trying to find the right path and the right way for each individual. There’s no book that you can just look up, the specific framework to educate within. Instead, here it’s about really finding the right approach for each specific individual, and that can many times be tricky.” (Participant no 5)

Scheduling driving at less stressful times, learning to drive cars with automatic transmission instead of manual gear, incorporating outdoor theoretical lessons, and offering shorter lessons with more breaks are examples of the adaptations mentioned. One instructor emphasized that it’s not just about providing support, but ensuring that the student receives the right support tailored to their specific needs, which requires careful assessment.

“It’s on a personal level, an individual level, I mean, saying that a person with a diagnosis should get support, yes, but what kind of support, that is what we need to find out.” (Participant no 8)

3.3.2 Enhancing understanding

The driving instructors described using guiding questions to encourage reflection and help students arrive at answers on their

own, and that this technique helps identify knowledge gaps, which can be addressed individually. Additionally, they described asking evaluative questions about mistakes, focusing on what happened, why, and how to improve, often in the context of real driving scenarios. The driving instructors described sometimes breaking scenarios into parts, discussing each one separately to ensure a complete understanding. Some of the participants also have students evaluate their own driving, offering insight into the student’s thought process. All driving instructors stressed the importance of clear, concrete, and specific communication, giving concise instructions and allowing students time to process the information.

Furthermore, the driving instructors reported that they use a lot of illustrations to explain and increase understanding, for example by drawing, using pictures, maps or sometimes LEGOs to demonstrate different driving situations, such as how braking distance varies at different speeds. One instructor also mentioned driving simulators as a useful tool for practicing risk awareness as well as increasing both practical and theoretical understanding. A few driving instructors expressed a desire for more tools to help mitigate difficulties in understanding. The driving instructors also emphasized the use of demonstrations to foster understanding of certain driving operations.

“I demonstrate a lot; I show certain exercises so that the students get a clear picture and can sit, watch, and analyze from the passenger seat.” (Participant 5)

The demonstration, along with explanations of what is being done and why, was described as preparation for the students before they try it themselves. The instructor called this technique ‘narrative driving’. Another respondent described using roleplaying to demonstrate the risks of not slowing down at intersections.

According to the participants, practice is essential to understanding driving and

traffic situations, especially for students with various challenges, as it helps them integrate theoretical aspects they struggle with. One driving instructor highlighted the benefits of using a driving simulator, which allows students to practice behind the wheel, experience risky driving situations in a safe way, and interactively practice theory, benefiting those who struggle with concentration and sustained attention.

3.3.3 Stepwise learning and Repetition

More than a third of the driving instructors discussed breaking the learning process into smaller, more structured steps for students with NDDs. They highlighted the importance of taking one step at a time and spending additional time on each step if necessary. The driving instructors explained that overwhelming students with too much information can be more hindering for those with NDDs. They mitigate this by focusing on providing one instruction at a time, particularly when teaching multitasking, for example by stopping the car when giving new instructions. This method involves starting slowly, gradually adding steps, and building up as the student gains confidence. For students who get stressed in busy situations, the driving instructors begin in calmer areas and slowly introduce more active environments as the student becomes comfortable.

Moreover, the driving instructors emphasized the importance of repetition for students with NDDs. They emphasized the importance of establishing a stable foundation, followed by repeated practice. This process begins with guided driving and clear instructions, which are gradually reduced as the student gains confidence and becomes capable of driving independently. They described working slowly, addressing any problems as they arise through repetition and constructive praise, ensuring that the student learns from mistakes and that the difficulty level increases gradually. The driving instructors also talked about the importance of practicing driving at home and of having a private instructor (for

example a parent) with sufficient knowledge and understanding about the student and their needs in the context of learning to drive.

In sum, the driving instructors described various strategies and methods they use when working with students with NDDs, emphasizing the importance of tailoring their teaching approaches to each student's unique needs. To improve understanding, they use reflective questions, along with illustrations and demonstrations. Additionally, they use repetition as well as breaking the learning process into smaller, more structured and manageable steps.

4. Discussion

The aim of this study was to explore driving instructors' experiences of teaching individuals with NDDs during driver education. The research questions to be explored were, what challenges do driving instructors experience when working with individuals with NDDs during the process of teaching and learning to drive? Additionally, how do driving instructors address these challenges in terms of teaching methods and strategies?

To mitigate the challenges student drivers with NDDs face, the identified categories work together to address the *Challenges* in a nuanced and broad way. *Creating facilitating learning conditions* forms the foundation for optimal learning conditions, while *Teaching methods and strategies* operates within this framework to actively guide and drive the learning process forward. Together they create *Adapted and targeted support in a facilitating learning environment*.

4.1 Challenges

Students with NDDs were often described as having difficulties related to the cognitive prerequisites for driving, such as managing situations with high levels of stimuli, making quick decisions, and flexible reasoning. These challenges align with core characteristics of NDDs, such as ASD and ADHD (APA, 2013), and are supported by previous research

identifying mental inflexibility, distractibility, communication difficulties and sensory processing difficulties among student drivers with NDDs (e.g., Classen et al., 2013; Myers et al., 2021; Mercier et al., 2024; Hazen et al., 2014; Thorslund & Lidestam, 2025). Challenges related to the theoretical aspects of driver education were also highlighted, particularly among students with ADHD and co-occurring NDDs, in line with earlier findings (Almberg et al., 2015; Thorslund & Lidestam, 2025).

The findings also show that a challenge for student drivers with NDDs is their need for additional resources. Because their learning process is typically longer, these students require more time and specialized support from driving schools, as well as greater personal investment in terms of time, finances, motivation, and energy. This aligns with previous research showing that having an NDD increases the number of driving lessons needed and, consequently, the overall cost—an obstacle for many learners (Vindin et al., 2021; Almberg et al., 2015)

4.2 Facilitating learning and teaching methods

Driving instructors use specific methods to support students with NDDs, including a structured learning environment, effective communication, rapport-building, understanding individual needs, and planning support. These practices align with earlier research on teaching strategies for driver learners with NDDs (Vindin et al., 2021) and form the basis for optimal learning. Effective communication is especially important for reducing misunderstandings among learners with ASD (Tyler, 2013; APA, 2013). Previous studies highlight communication challenges in driver training (Thorslund & Lidestam, 2025) and the value of concise language (Vindin et al., 2021). This study adds detailed insights and practical examples relevant not only to ASD but to other NDDs.

Instructors use communication deliberately to match each learner's needs, employing simplified and direct language (Tyler, 2013) and guiding questions to identify individual

struggles, which is crucial for learners who may have difficulty articulating challenges. They also attend to verbal and nonverbal cues, consistent with Argyle's Communication Cycle (Argyle, 1976). Communication further supports the pedagogical relationship essential for learning (Suciu, 2014; Zhou, 2021). Rapport, trust, and structure were emphasized as key for reducing anxiety and supporting task completion (Hallberg, 2009; Moëll et al., 2015; Ross et al., 2018; Vindin et al., 2021).

To facilitate understanding, instructors use reflective questions, illustrations, demonstrations, repetition, and stepwise instruction, consistent with parsing methods in task-based learning (Björklund, 2018; Rauniomaa et al., 2018). Some also use driving simulators to support concentration difficulties, a method effective in general driver education but not previously studied for NDDs (Alonso et al., 2023; Hertzberg et al., 2025). These strategies illustrate practical ways to support learners with NDDs.

Tailoring instruction to individual needs aligns with adaptive teaching (Parsons, 2008; Parsons et al., 2018). Reflective questions resemble Socratic questioning, which supports critical thinking and reduces rigid thinking (Elder & Paul, 1998; Paul & Elder, 2007; Chew et al., 2019), potentially benefiting learners with NDDs. Instructors also use illustrations, demonstrations, and guided verbal instructions. Although no single method suits all individuals, concrete and visual support is widely recommended (Grandin, 1995; Janzen, 1996; Cohen & Sloan, 2007) and can help learners with ASD understand abstract concepts (Janzen, 1996; Dalrymple, 1989; Rao & Gagie, 2006). However, evidence for a primarily visual learning profile in ASD, IDD, or ADHD is inconsistent (Trembath et al., 2015).

Distinct learner profiles lack empirical support (Newton, 2015). Research on cognitive structure shows that single-modality instruction increases cognitive overload, whereas multimodal input reduces it (Low & Sweller, 2005; Mayer, 2001; Moreno & Mayer,

2007). A multimodal approach is therefore beneficial, especially for learners with NDDs (APA, 2013). By combining visual, kinesthetic, and auditory methods, instructors use a multimodal approach aligned with research on sensory experience in driver education (Björklund Flärd, 2024) and multimodal enrichment (Mathias & von Kriegstein, 2023). Together with adapted teaching, this helps mitigate challenges faced by learners with NDDs.

Most strategies presented are common in driver instruction (Björklund Flärd, 2024; Keskinen & Hernetkoski, 2011; Rismark & Sølvsberg, 2007), but this study shows they are adapted to address NDD-specific challenges. Instruction may be more concentrated or more spaced out depending on needs. Learners with NDDs often require more structure, resources, expertise, and scaffolding, as well as reduced stimulation and more breaks. While core teaching principles remain the same, the nature of the challenge determines the support required. This underpins the study's main theme: adapted and targeted support within a facilitating learning environment, where tailoring methods to each learner is central to successful instruction.

4.3 Strengths, limitations and future research

This study confirms previous findings on driver education for learners with NDDs (Almberg et al., 2015; Cox et al., 2016; Vindin et al., 2021; Patrick et al., 2018) while providing updated insights into effective support strategies in Sweden. A primary strength is our broad NDD framing, which unlike earlier diagnosis-specific studies (Myers et al., 2021; Vindin et al., 2021; Chee et al., 2015) accounts for the high comorbidity and heterogeneity inherent in these conditions (APA, 2013; Bonti et al., 2024; Qi et al., 2020; Castellanos et al., 2006). This approach mirrors the real-world challenge where instructors must mitigate functional obstacles without always knowing a student's specific diagnosis (Cruz Puerto & Sandín Vázquez, 2024).

Regarding limitations, the participants' specialized expertise may limit the representativeness of the findings and introduce selection bias. However, this expertise was essential for addressing the study's specific aim: exploring pedagogical methods for students with NDDs. Furthermore, while the substantial variability in the participants' years of experience could affect how instructional tasks are interpreted, this diversity also enhances the study's ecological validity by reflecting the real-world variability within the profession.

Future research should assess driving instructors' general knowledge of NDDs, as such knowledge directly impacts instructional quality, a link already established in general education (Kos et al., 2004; Sciotto et al., 2016; Segall, 2008). Additionally, as this study relies on self-reports, observational data is needed to verify actual classroom practices. Finally, to gain a nuanced understanding of effective pedagogy, future studies should incorporate the learners' own perspectives, which remain under-represented in current literature (Almberg et al., 2015; Vindin et al., 2021), and further explore underutilized tools such as driving simulators.

5. Conclusion

This study explored driving instructors' experiences of teaching individuals with NDDs in Sweden, providing insights into how they address both structural and cognitive challenges. Findings highlight significant obstacles related to reasoning, information processing, and the need for additional resources. To mitigate these, instructors prioritize a structured, supportive learning environment characterized by effective communication and individualized adaptation. Key pedagogical strategies include breaking tasks into smaller steps, frequent repetition, concrete instructions, and the use of illustrations or demonstrations. These results suggest that targeted support within a facilitating environment is essential for the success of student drivers with NDDs. Future research should focus on developing

supportive pedagogical tools and assessing instructors' NDD-related knowledge. By identifying current teaching approaches and areas for improvement, this study provides a foundation for a more accessible and effective driver education system.

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Competing interests

The authors declare that they have no competing interests.

CRedit contribution

Lina Hertzberg: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing—original draft, Writing—review & editing. **Birgitta Thorslund:** Conceptualization, Methodology, Project administration, Supervision, Visualization, Writing—original draft, Writing—review & editing. **Helena Selander:** Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Visualization, Writing—original draft, Writing—review & editing.

Ethics

The study was conducted in accordance with established ethical guidelines for research (Swedish Research Council 2024). An

assessment was made that the collected material does not contain typical sensitive data. The interviews contain accounts from personal experiences, this was considered in both the handling of the data and the design of the study e.g. the participants in the study cannot be identified. All participants were informed about the purpose of the study and provided their informed consent. Data has been treated confidentially and in compliance with the General Data Protection Regulation (GDPR).

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Generative AI use in writing

During the preparation of this work the authors used Chat GPT 4 and Microsoft 365 Copilot to review language and for rephrasing and clarity. The output was reviewed and revised by the authors who take full responsibility for the content of the publication.

Prior dissemination

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